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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/803,876	03/19/2004	Eiji Ogawa	Q80555	7156

23373 7590 09/11/2006

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EXAMINER	
WEATHERBY, ELLSWORTH	
ART UNIT	PAPER NUMBER
3768	

DATE MAILED: 09/11/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/803,876	OGAWA, EIJI	
	Examiner	Art Unit	
	Ellsworth Weatherby	3768	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *9/7/2005*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

1. The information disclosure statement (IDS) submitted on 9/7/2005 was filed. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 102

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1, 3-8 and 17 are rejected under 35 U.S.C. 102(b) as being anticipated by Wright et al. (USPN 6,016,285).

Regarding claims 1 and 3, Wright et al. '285 discloses:

A transmitter for each channel is implemented with digital-to-analog converter (DAC) 8 and transmit amplifier 9. DAC 8 converts the digital samples of the transmit waveform to an analog signal. The transmit amplifier 9 sets the transmit power level and generates the high voltage pulses to drive the connected elements of the transducer array 1 for transmit beam formation (col. 21, lines 61-67).

The invention is capable of the simultaneous transmission of one or more beams of energy on transmit scan lines and of the simultaneous reception of reflected energy with one or more beams on receive scan lines using an electronic beamformer that

steers and/or translates both receive and transmit beams independently to effect scanning throughout a given field of view (col. 3, lines 42-48).

The digital demodulator 15 provides phasing, apodization, and rotation to baseband. The capability of forming multiple receive beams is effected by filter/delay 14 and digital demodulator 15. These processing elements can be time-division multiplexed on a sample-by-sample basis to calculate two output signals (corresponding to signals on each of two receive beams) from one input signal. The two output signals are thus time-interleaved on a sample-by-sample basis, where each sample is an I and Q pair. It is understood that such time-division multiplexing can accomplish signal processing with for example two, three, four, etc., transmit beams associated with four, six, eight, etc., receive beams (col. 22 lines 15-29).

Novel aspects of the present invention include [1] use of one or more simultaneously formed receive beams in combination with one or more simultaneously excited transmit beams, [2] storage of coherent samples [i.e., samples that preserve relative amplitude and phase relationships among signals, as defined below] of signals associated with each receive beam, and [3] before detection, synthesis of one or more new coherent samples. The one or more new coherent samples are calculated using stored coherent samples associated with a plurality of distinct receive beams [i.e., two or more receive beams that are associated with spatially different receive scan lines and/or with temporally different transmit excitations, as defined below] through the operations of [a] interpolation [including linear interpolation or weighted sums] or [b] extrapolation or [c] other methods (col. 3, lines 15-30, col. 9 lines 30-40).

Regarding claims 4-8, Wright et al. '285 discloses as noted above. Furthermore, Wright et al. 285 discloses: The method and apparatus is additionally for acquiring and storing coherent samples retaining both phase and amplitude information of those electrical signals obtained on the receive scan lines throughout at least a portion of the field of view, and for combining stored coherent samples associated with distinct receive beams to synthesize new coherent image samples aligned on synthetic scan lines which are distinct from any one of [1] receive scan lines on which a signal was sensed, [2] transmit scan lines on which a signal was directed, or [3] transmit scan lines and receive scan lines (abstract).

The system acquires and stores coherent samples of received signals associated with each receive beam and performs interpolations (weighted summations, or otherwise), and/or extrapolations and/or other computations with respect to stored coherent samples associated with distinct receive beams to synthesize new coherent samples on synthetic scan lines that are spatially distinct from the receive scan lines and/or spatially distinct from the transmit scan lines and/or both (col. 3, lines 49-57).

Regarding claim 17, Wright et al. '285 discloses a method of transmitting at least one ultrasonic beam by driving plural transducers in a transducer array (col. 21, lines 61-67); Performing reception focusing so as to form a reception focal point in at least one region within the object thereby obtaining plural detection signals relating to said at leas one region (col. 22 lines 15-29); and calculating image data relating to said at least one region on the basis of plural detection signals relating to said at least one region and plural different acoustic pressure intensity profiles set based on acoustic pressure

intensity distribution formed by transmitting ultrasonic beams and the reception focusing to be formed on them (col. 3, lines 15-30, col. 9 lines 30-40).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 2 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wright et al. (USPN 6,016,285) in view of Wright et al. (USPN 6,110,116).

Regarding claims 2 and 16, Wright et al. '285 discloses a method of transmitting at least one ultrasonic beam by driving plural transducers in a transducer array (col. 21, lines 61-67); Performing reception focusing so as to form a reception focal point in at least one region within the object thereby obtaining plural detection signals relating to said at leas one region (col. 22 lines 15-29); and calculating image data relating to said at least one region on the basis of stored plural detection signals relating to said at least one region and plural different acoustic pressure intensity profiles set based on acoustic pressure intensity distribution formed by transmitting ultrasonic beams and the reception focusing to be formed on them (col. 3, lines 15-30, col. 9 lines 30-40).

Wright et al. '285 does not explicitly disclose signal reception in plural regions in an isochronal surface.

Wright et al. '285 also does not explicitly disclose a correction means for correcting acoustic pressure intensity profiles corresponding to a second isochronal surface based on the detection of signals corresponding to a first isochronal surface

Wright et al. '116 discloses signal reception at multiple isochronal surfaces: The receive beamformer (Figure 1) samples data at a plurality of focal depths [r.sub.1, r.sub.2, r.sub.3] along each scan line. In the digital receive signal path of the present invention, transducer array signals can be selectively separated into data representative of multiple individual beams (col. 10, lines 41-50).

The digital receive beamformer allows calculations of per-channel dynamic focus delay, phase, apodization, and calibration values for each receiver signal sample (abstract).

This system exploits the multi-beam transmit and multi-beam receive capability of the invention to acquire and store coherent [pre-detection] samples of receive beam data along actual scan lines and to perform interpolation of the stored coherent samples to synthesize new coherent samples at new range locations along existing scan lines or along synthetically-created scan lines (cols. 15-16, lines 65-67 & 1-6).

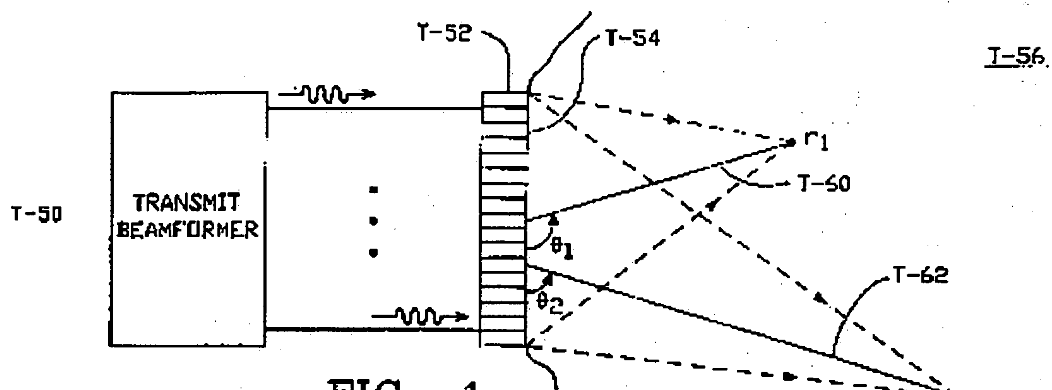

FIG.–1a

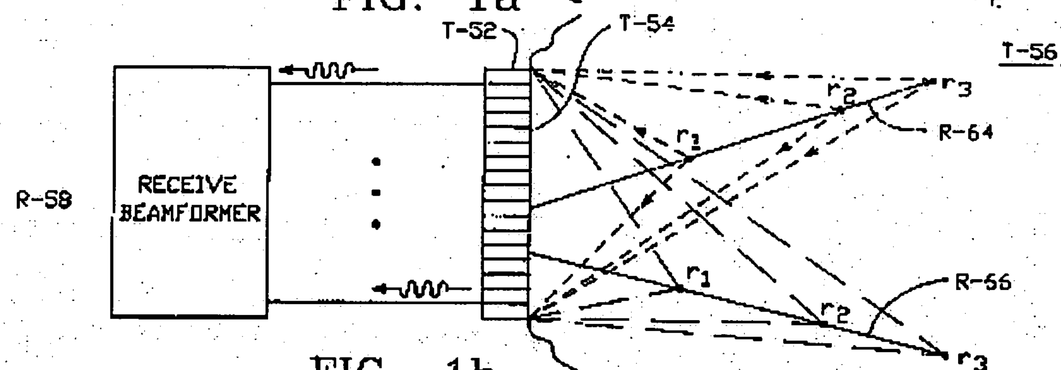

FIG.–1b

It would have been obvious to combine the coherent image invention of Wright et al. '285 with the receive beamformer of Wright et al. '116. The motivation to do so would be to increase the amount of data for interpolation in order to synthesize new coherent samples at new depths. Furthermore the invention of Wright et al. '116 is referenced in the disclosure of Wright et al. '285.

5. Claims 9-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wright et al. '285 in view of Clark (USPN 5,976,089).

Wright et al. '285 discloses a method of transmitting at least one ultrasonic beam in plural directions by driving plural transducers in a transducer array (col. 21, lines 61-

67); Performing reception focusing so as to form a reception focal point in at least one region within the object thereby obtaining plural detection signals relating to said at leas one region (col. 22 lines 15-29); and calculating image data relating to said at least one region on the basis of plural detection signals relating to said at least one region and plural different acoustic pressure intensity profiles set based on acoustic pressure intensity distribution formed by transmitting ultrasonic beams and the reception focusing to be formed on them (col. 3, lines 15-30, col. 9 lines 30-40).

Wright et al. '285 does not disclose calculating image data by obtaining a solution to simultaneous equations which have image data relating to at least one region as unknown and are constructed based on the plural detection signals relating to at least one region.

Wright et al. '285 also does not disclose a calculating means using matrices to calculate the image data by obtaining and image data vector "x" from an equation Ax=b where "b" represents a vector having components corresponding to the plural detection signal relating to said at least one region and "A" represents a matrix having components corresponding to plural acoustic intensity ratios in plural acoustic pressure intensity profiles relating to at least one region.

Wright et al. '285 also does not disclose obtaining the vector "x" by obtaining a generalized inverse matrix of the matrix "A" which satisfies the equation Ax=b.

Wright et al. '285 also does not disclose obtaining the vector "x" by performing singular value decomposition on matrix "A" and obtaining a generalized inverse matrix "A" which has a reduced rank.

Wright et al. '285 also does not disclose a calculating means wherein said calculating means obtains a least square solution of the vector "x" which satisfies the equation Ax = b in the case where the matrix "A" have "m" rows and "n" columns where m > n.

Wright et al. '285 also does not disclose a calculating means wherein said calculating means obtains the vector "x" by obtraining an inverse matrix of the matrix "A" in accordance with one of (i) an exact method including a sweeping out method and (ii) an iterative method in the case where the matrix "A" is a square matrix and a regular matrix.

Clark '089 discloses: In step 114, simultaneous linear equations are used to calculate interpolation coefficients used by interpolators shown in FIGS. 3 and 3A. These equations specify the goals of balancing the resulting beams formed by interpolating two round-trip beams that are identically aligned and are formed from two transmit beams emitted along two neighboring transmit lines. With the round-trip beams already oriented correctly before the interpolation, the interpolation coefficients can be used for optimizing a selected characteristic of the image. The selected characteristic is, for example, the beam profile of the interpolated beam (col. 9, lines 43-53).

Clark '089 also discloses: simultaneous equations are combined into a single matrix equation and solved where X is the matrix containing round-trip beam magnitudes, C is the "vector" of coefficients, and A is the "goal" vector. X is not a square matrix, because the specifications are over-constrained (there are more equations than unknown coefficients). Therefore, it is not possible to solve the matrix equation exactly

using the inverse matrix method. However, the Moore-Penrose, pseudo-inverse method, based on singular value decomposition, can be used to obtain a solution that is optimal in the sense of having the lowest mean square magnitude (col. 11, lines 26-55).

It would have been obvious to combine method and apparatus for coherent image formation of Wright et al. '285 with the matrix calculations for use in 3D ultrasound disclosed by Clark '089. The motivation to do so would be to perform the most stable matrix computations on the receive data using the most stable calculating methods.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Cole et al. (USPN 5,856,955).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ellsworth Weatherby whose telephone number is (571) 272-2248. The examiner can normally be reached on M-F 8:30 a.m. - 5:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eleni Mantis-Mercader can be reached on (571) 272-4740. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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